

A LIST OF THE PAPILIONIDAE (LEPIDOPTERA) OF THE SOLOMON ISLANDS, WITH NOTES ON THEIR GEOGRAPHICAL DISTRIBUTION

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Abstract

An account is given of the Papilionidae of the Solomon Islands, with taxonomic and distribution notes. The status of *O. allotiei* Rothschild, *P. ponceleti* Le Moult, *P. erskinei* Mathew and *P. ptolychus* Godman and Salvin, is discussed. An attempt is made to show the relationships between this fauna and those of other parts of the Australian region.

Introduction

Several papers on the papilionid butterflies of the Solomon Islands have appeared, but none contain a comprehensive discussion of all the species. It is hoped that the present list may, to some extent, rectify this situation.

The paper is based on extensive studies of the literature, on morphological studies of specimens in various collections, and on recent field data submitted by resident collectors. The Solomon islands are inhabited by 15 species of Papilionidae representing four genera. *Papilio oregon*, which inhabits S. Cruz island, has been included in the systematic section, but not in the data analysis.

Geography

The Solomon group constitutes a long island arc in the South West Pacific consisting of one major and several minor clusters of islands covering an area of some 33900 km² and located east of New Guinea. The arc is oriented roughly NW-SE and in the NW, submarine mountains connect this group with the Bismarck Islands. Southwards, the Archipelago is continuous with the New Hebrides, which are separated from the Solomon group by the Santa Cruz Basin. This group of islands is probably not geologically linked to the Solomons but rather to the New Hebrides (Gressitt, 1961).

The Solomon Archipelago comprises two parallel rows of islands (Fig. 1), separated by "The Slot" channel. The main islands are Buka, Bougainville, Choiseul, Santa Isabel, Guadalcanal, Malaita, and Florida. The northernmost island is Buka and the southernmost San Cristobal. The rather isolated New Georgia Group with Vella la Vella, Gizo and Kolombangara, occupies a central position within the Archipelago.

The topography and vegetation are varied. Tropical rain forest covers large parts of the islands, except where cleared by man and on geologically younger ground, where a savannah-type vegetation often prevails, with lalang-grass (*Imperata*) etc. With the exception of the atoll-islands, all are more or less mountainous, with densely forested interiors. Mt. Lammas of Guadalcanal is nearly 2500 m high and several other islands of the group have mountains reaching about 1000 m. There are several active volcanoes, e.g. Balbi (3123 m) and Bagana (2251 m), both in Bougainville. Mountain slopes and hills are often covered extensively by dense rain forest, with various palms, hardwood trees, *Ficus* etc. The low-altitude vegetation consists mainly of ferns, banana trees and their like, with epiphytes and lianas. In coastal areas vast grounds

are cultivated and scattered secondary forests exist inland. Along tidal river courses, terminating in the ocean, swamplands and mangroves are often present. In Guadalcanal the grassy plains appear to be the result of relatively recent, but nevertheless total, clearing of the virgin forest. The climate is equatorial, with some seasonal variation in temperature, wind and precipitation. During the rainy season a monsoon-type wind prevails from April to November in large parts of the Solomons.

Systematic section

The following abbreviations have been used below: FW, fore wing; HW, hind wing

Ornithoptera victoriae (Gray), 1856

This highly variable species has been discussed by Schmid (1970b, 1973b) who placed *resplendens* Ehrmann as a synonym of *regis* Rothschild, with which I fully concur. Numerous specimens of most of the described subspecies are difficult to assign to one or the other taxon, thus reflecting the great variability of the species. The populations from the New Georgia Group, described as *rubianus* Rothschild, are characterised by a greater stability of the phenotype and it may be speculated that they have been isolated for a longer time.

The following subspecies have been described:—

O. victoriae victoriae (Gray, 1856). Type loc.: not stated [Guadalcanal]

O. victoriae reginae (Salvin, 1888). Type loc.: Malaita: NW Bay

O. victoriae regis (Rothschild, 1895). Type loc.: Bougainville and Alu

O. victoriae isabellae (Rothschild and Jordan, 1901). Type loc.: Isabel

O. victoriae epiphanes Schmid, 1970. Type loc.: San Cristobal: Manowiriwiri

O. victoriae rubianus (Rothschild, 1904). Type loc.: Rendova

Distribution:— Bougainville; Alu; Shortland Is.; Rubiana; Kolombangara; New Georgia; Munda; Rendova; Ranonga; Guadalcanal: Poha, and Aola; Tulagi; Florida; Nggela; Malaita: Auki; Choiseul: Sasamuga and Kia, Nanango; St. Isabel: Mt. Marescot; S. Cristobal: Manowiriwiri, Kira Kira, Wainou, Star Harbour; Bauro.

Ornithoptera allottei (Rothschild), 1914

The status of this taxon has been discussed by McAlpine (1970), Schmid (1970a, 1973b), D'Abrera (1975) and Haugum and Low (1978). Rousseau-Decelle (1939) was the first to suggest that *allottei* might be a hybrid of *O. victoriae* x *O. priamus urvillianus*, but Pere Allotte, the discoverer of the specimen, had earlier suggested this in a letter to Rothschild (Rothschild, 1914). Subsequent authors have treated *allottei* alternatively as a good species or as a hybrid in the absence of conclusive proof of one or the other. Schmid (1970a) found diagnostic characters to support the distinctiveness of *allottei* whilst McAlpine (*l.c.*) concluded (by what was claimed to be a lack of morphological features of its own) that *allottei* is a hybrid. Both Haugum and Low (*l.c.*) and Blandin (1973) are dubious about considering *allottei* a good species. In the light of recent findings of natural hybridization in other *Ornithoptera* and in *Ornithoptera* x *Troides* (Straatman, 1976; Sands and Sawyer, 1977), which is not as rare as was originally believed, new strength has been added to the hybrid origin theory for *allottei*, with which I agree. Moreover, *O. allottei* has only been recorded from the south of Bougainville and Malaita (Morgan, pers. comm.), where there are relatively high population densities of both *O. victoriae* and *O. priamus urvillianus* (Straatman, 1976 and pers. comm.). In these localities freely interspecific mating has sometimes been observed and the hatched larvae have been successfully reared through the initial instars, but unfortunately were eaten later by frogs (Straatman, pers. comm.).

Distribution:— Bougainville: Buin; South of Malaita.

Ornithoptera priamus urvillianus (Guérin-Méneville), 1838

A marked geographic variation is apparent in this widespread subspecies, which is distributed practically throughout the Solomon Islands. A subspecies *burkei* Clark, 1944.



Fig. 1. Map of the Solomon Archipelago.

was described from the southern Solomons but was placed as a synonym of *urvillianus* by Howarth (1977), whom I support. McAlpine (*l.c.*) and D'Abrera (1975) consider this taxon a valid species different from *O. priamus* L.

Distribution:—Buka; Bougainville: Buin, Kunua; Treasury Is.; New Georgia; Gizo; Rendova; Bango Pingo; Isabel: Boala, Tatamba; Choiseul: Nanango; Malaita: Tanabu; Fauro; Tulagi; Florida; Guadalcanal: Honiara; Savo. It probably occurs on the numerous minor islets, but it has never been reported from Ugi and S. Cristobal.

Pachliopta polydorus (Linnaeus), 1758

This species is the sole representative of the genus in the Solomons and was discussed in detail by Howarth and Racheli (1975).

There are three distinct subspecies:—

P. polydorus polydaemon (Mathew), 1887. Type loc.: Ugi Is.

P. polydorus ulawaensis (Joicey and Talbot), 1918. Type loc.: Ulawa Is.

P. polydorus polypemon (Mathew), 1887. Type loc.: Treasury Is.

Distribution:—Bougainville: Buin; Gauro; Alu; Treasury Is.; Shortland Is.; Vella la Vella; Gizo; Ranongga; Rendova; Choiseul; Isabel: Kia; Malaita; Florida; Guadalcanal: Honiara, Tetere; Ulawa; Ugi; S. Cristobal.

Papilio bridgei Mathew, 1886 (Figs 2-9)

This species shows considerable phenotypic variability along its range, however it is constant within each insular population. The phenotype of Malaita appears to be hitherto unrecorded and is interesting since it is intermediate between those of New Georgia and S. Cristobal. The ♂ specimens from Malaita show the post discal band of FWs rather poorly defined. It is complete on the upperside of FWs, with no black lines along the veins crossing the relatively large band of HWs. It seems probable that there is a formation of a clinal series in this species, with regard to this character. The ♀♀ are slightly larger than those of other populations (length of FW 85 mm). The discal patches of both FWs and HWs are more darkened, the marginal white spots enlarged, the submarginal spots large and filled with orange. Upon examination of the holotype ♂ in the British Museum collection, *Papilio erskinei* Mathew, 1886, was found to be conspecific with *P. bridgei*.

A further ♂ recently received from S. Cristobal, is similar to the holotype, except that it has traces of submarginal spots in S2 and S3 on the underside of HWs.

No attempt was made in the list by Munroe (1961) to give the status of *P. erskinei* and this taxon was presumably overlooked by D'Abrera (1971) who subsequently (1978) considered it as a local form of *P. woodfordi*.

As far as *tryoni* Mathew 1889 is concerned, I had the opportunity to examine a colour slide of the holotype ♂. The specimen, which is very battered, is said to come from Ugi Is., namely the locality where *P. erskinei* flies. It might be that different populations of *P. bridgei* occur in different parts of the island, even though this hypothesis is rather doubtful. The two other possibilities are either that *tryoni* is an aberration of *erskinei* or that the locality is wrong. This latter possibility is supported by the fact that the holotype of *tryoni* resembles all the other populations of *bridgei* within the Solomons, except that of S. Cristobal. In fact, the apical patch of both FWs is missing, a costal streak is present on the upper side of the HWs and the colouration of the submarginal spots on the underside of the HWs is light yellow-green. These characteristics are absent in *P. erskinei*. Moreover, Jordan (1909) described two females that he referred to as females of *P. tryoni*, but which are undoubtedly females of *P. erskinei*. Two females of this taxon, recently received from S. Cristobal, correspond to Jordan's diagnosis yet are females of *P. bridgei*, from which it may be concluded that *P. erskinei* is conspecific with *P. bridgei*.

Since we cannot completely depend upon the previously recorded localities, the type locality of *Papilio bridgei erskinei* Mathew 1886 Stat. nov., should be restricted to S. Cristobal.

Finally, I have some doubts about the status of *tryoni* until new material becomes available.

The geographical distribution of *P. bridgei* may be summarized as follows:—

P. bridgei bridgei Mathew, 1886. Type loc.: Treasury Is.

P. bridgei prospero Grose-Smith, 1889. Type loc.: Rubiana

P. bridgei ortegae Rothschild, 1904. Type loc.: Florida

P. bridgei hecateus Godman & Salvin, 1888. Type loc.: Guadalcanal

P. bridgei erskinei Mathew, 1886. Type loc.: Ugi Is.

P. bridgei tryoni Mathew, 1889. Type loc.: Ugi Is. ?

Distribution:— Buka; Bougainville; Shortland Is.; Alu; Fauro; Treasury Is.; Choiseul; Masamasa; Isabel: Tatamba, Sepi; Malaita: Auki; Rubiana; Gizo; New Georgia: Munda; Rendova; Vella la Vella; Florida; Gela; Guadalcanal: Koala Ridge, Honiara; Ugi; S. Cristobal.

Papilio oberon Grose-Smith, 1897

This species shows a marked stability of the pattern in a long series examined. Jordan (1909) suggested that the affinities of *P. oberon* are with *Papilio aegaeus* Donovan. This may be so, however it resembles morphologically the Australian subspecies of *P. aegaeus* more than any forms which are geographically nearer to it.

Distribution:— S. Cruz: Tevai.

Papilio woodfordi Godman and Salvin, 1888

This species is strikingly variable, but stable within each population. Having examined large series of specimens, I have come to the conclusion that the taxon known as *ptolychnus* Godman and Salvin, 1888 is conspecific with this species.

Four geographical subspecies should therefore be considered:—

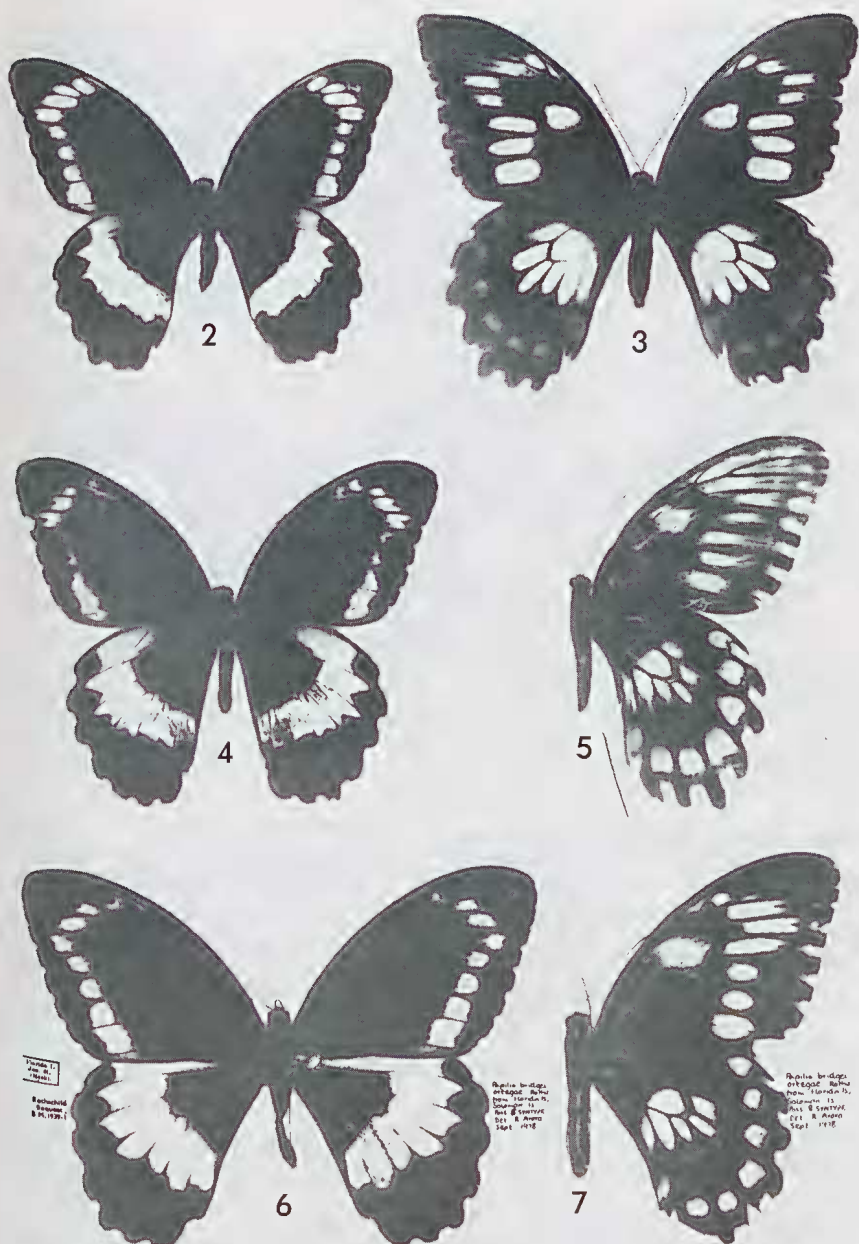
P. woodfordi woodfordi Godman and Salvin, 1888. Type loc.: Alu and Fauro

P. woodfordi ariel Grose-Smith, 1889. Type loc.: Isabel: Estrella Bay

P. woodfordi laarchus Godman and Salvin, 1888. Type loc.: Rubiana

P. woodfordi ptolychnus Godman and Salvin. Type loc.: Guadalcanal: Aola. Stat. nov.

Distribution:— Buka; Bougainville: Buin; Alu; Fauro; Shortland Is.: Tiap; Rubiana; New Georgia; Gizo; Kolombangara; Isabel: Tatamba, Sepi, Holibara, Hageulu; Malaita; Choiseul; Guadalcanal: White River and Mt. Balbi; Florida.



Figs 2-7. (2-3) *P. bridgei erskineji*: (2) ♂ upperside, S. Cristobal, 28.viii.1974 (3) ♀ upperside, S. Cristobal, 28.viii.1974; (4-5) *P. bridgei* ssp.; (4) ♂ upperside, Malaita, Auki, 11.v.1973, (5) ♀ upperside, Malaita, 4.vii.1973; (6-7) *P. bridgei ortegae*: (6) ♂ upperside, Florida, i.1901, Meek leg., syntype, Brit. Mus. (Nat. Hist.), (7) ♀ upperside, data as for ♂. Specimens in author's collection unless otherwise stated.

Papilio fuscus Goeze, 1779 (Figs 10-11)

A widely distributed and highly variable species. The arrangement, traditionally considered for all populations of central and south Solomons referred to ssp. *xenophilus* Mathew 1886, by Rothschild (1895), Jordan (*l.c.*) and D'Abbrera (1971, 1978), appears to be erroneous and the name *xenophilus* should be restricted to the populations of Ugi and S. Cristobal. They may be distinguished from populations of other Solomons on account of the constant pure white bands of both wings and also their smaller size. As pointed out by Jordan (*l.c.*), *P. fuscus xenophilus* appears to be closely related to *Papilio canopus* Westwood, 1842; the relationships between these two taxa will be discussed below.

In my opinion only two subspecies should be considered in the Solomon Islands: *P. fuscus hasterti* Ribbe, 1907 (Type loc. Bougainville: Kieta or Kieta), distributed on the main chain except Ugi and S. Cristobal where *P. fuscus xenophilus* Mathew, 1886 (Type loc. Ugi) occurs. The name *epibomius* Fruhstorfer, 1907, used to designate the population of Florida, should be regarded as a synonym of *hasterti* Ribbe.

Distribution:—Buka; Bougainville: Kieta; Alu; Shortland Is.; Isabel; New Georgia; Gizo; Rendova; Malaita; Auki; Florida; Russel Is.: Pavuvu; Guadalcanal; Ugi; S. Cristobal.

Papilio poncelleti Le Moul, 1933

This supposed species has been described by Le Moul (1933), on the basis of one male and one female from Bougainville, Kieta. Since then no other author has recorded it. Unfortunately, I have been unable to examine these specimens which were sold in 1966 at Rousseau-Decelle's auction in Paris.

Le Moul (*l.c.*), in his description, noted the great similarity of *poncelleti* with *woodfordi* and *fuscus*, it being intermediate in many characters between these two species.

Straatman (1962) gives illustrations of an experimental hybrid resulting from *P. aegaeus aegaeus* Donovan x *P. fuscus capaneus* Westwood. Even though there are no pattern relationships between this hybrid and *poncelleti*, the tail reduced to a stump in this hybrid is not unlike that of *poncelleti*. Many other records of crosses between tailed and untailed papilios show that the tails of resulting off-spring are reduced in length. The status of *poncelleti* is questionable and its hybrid origin, *P. fuscus* x *P. woodfordi* seems a likely explanation.

Papilio phestus Guérin-Méneville, 1830

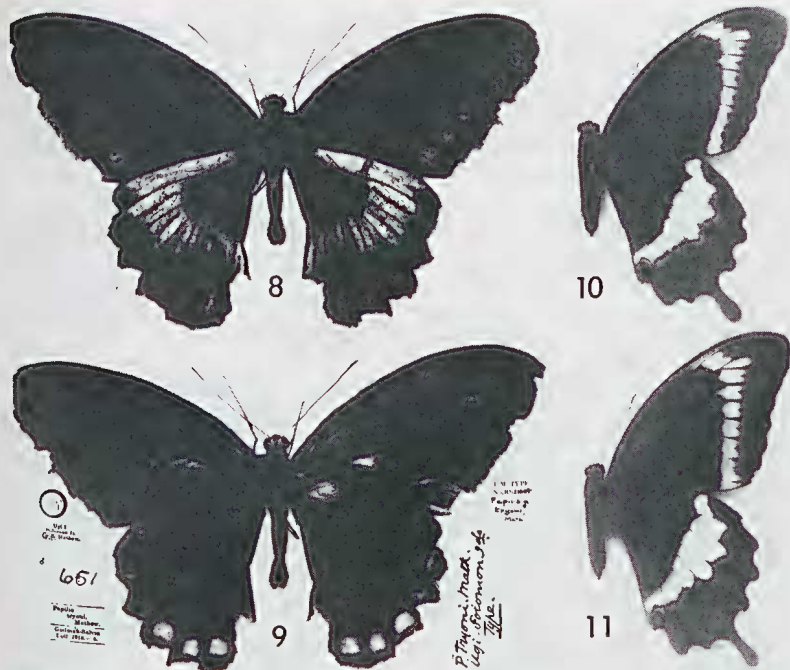
Apparently never recorded from Malaita, Guadalcanal and S. Cristobal. The most southern locality known to the author is Russel Is. (1 ♂, in Rijksmuseum van Natuurlijke Historie, Leiden). It is possible that the various populations recorded refer to only one subspecies, namely *minusculus* Ribbe, 1898 (Type loc. Shortland Is.), even though some populations may be distinguishable. The white discal spots on the underside of HWs are mostly reduced in the northern populations while the same spots are larger and similar to those of nominotypical *phestus* in specimens from central and southern Solomons.

Distribution:—Bougainville: Buin; Alu; Treasury Is.; Choiseul; Isabel: Tatamba; Rubiana; New Georgia; Gizo; Vella la Vella; Kolombangara; Russel Is.

Papilio ulysses Linnaeus, 1758

The subspecies were discussed by Jordan (*l.c.*) who applied various names to the female forms occurring in the Solomons. There is one geographical subspecies on the main Solomon chain, another in the New Georgia Group and a third in the Shortlands and on Bougainville. Subspecies *orsippus* Godman and Salvin, 1888 is distributed on Guadalcanal (Type loc.), Choiseul, Isabel and Florida, and is dimorphic in the female. Subspecies *georgius* Rothschild, 1908 occurs on Gizo (type loc.), Kolombangara, Ranongga and Vella la Vella of the New Georgia Group, and subspecies *nigerrimus* Ribbe, 1898 on Bougainville and the Shortland Islands.

Distribution:—Bougainville: Buin; Shortland Is.; Alu; Isabel: Sepi; Choiseul; Vella la Vella; Gizo; Kolombangara; Ranongga; Guadalcanal: Honiara, Koala Ridge; New Georgia; Florida.



Figs 8-11. (8-9) *P. bridgei tryoni*: (8) ♂ upperside, Ugi Is., "Type", Brit. Mus. (Nat. Hist), (9) ♂ underside, same specimen; (10-11) *P. fuscus xenophilus*: (10) ♂ upperside, S. Cristobal, ii.iii.1974, (11) ♀ upperside, S. Cristobal, 2.iii.1974. Specimens in author's collection unless otherwise stated.

Papilio toboroi Ribbe, 1907 (Figs 12-13)

The biology and ecology of this species was described by Straatman (1975), the taxonomy by Racheli (1979). The species seems to be rather localised and distributed only in Bougainville, Isabel and Malaita.

Two subspecies are recognised, namely:—

P. toboroi toboroi Ribbe, 1907. (Type loc. Bougainville: Gieta)

P. toboroi straatmani Racheli, 1979. (Type loc. South Isabel: Holibara)

Distribution:— Bougainville: Gieta, Borabere, Tiop; Isabel: Holibara; Malaita.

Graphium codrus (Cramer), 1779

Widespread but apparently uncommon in the Solomons. The taxonomy and distribution were discussed by Yoshida (1972) and Racheli (1979).

Four subspecies can be distinguished:—

G. codrus gabriellae Racheli, 1979 (= *solon* Godman and Salvin, 1888 nec *solon* Fabricius, 1793). Type loc.: Guadalcanal: Aola.

G. codrus pisidice (Godman and Salvin), 1888. Type loc.: Malaita: North-west Bay.

G. codrus tenebrionis (Rothschild), 1895. Type loc.: New Georgia.

G. codrus christobalus (Jordan), 1909. Type loc.: S. Cristobal.

Distribution:— Bougainville; Alu; Shortland Is.; Choiseul; Malaita: Auki; Rendova; Ranongga; Vella la Vella; Gizo; New Georgia; Florida; Guadalcanal; S. Cristobal.

Graphium sarpedon (Linnaeus), 1758

Not recorded from Malaita and S. Cristobal but otherwise widespread in the Solomons in two, or possibly three, subspecies:—

G. sarpedon isander (Godman and Salvin), 1888. Type loc.: Guadalcanal: Aola

G. sarpedon impar (Rothschild), 1895. Type loc.: New Georgia

And possibly:— *G. sarpedon shortlandica* (Ribbe), 1900. Type loc.: Shortlands, but since such a meagre quantity of specimens is known, it is impossible to decide whether or not it represents a valid subspecies

Distribution:— Bougainville; Shortlands; Fauro; Alu; Isabel; Choiseul; Kolombangara; Gizo; Vella la Vella; Rendova; Rubiana; New Georgia; Guadalcanal; Florida.

***Graphium mendana* (Godman and Salvin), 1888 (Figs 14-16)**

This species seems to be rather rare and is not represented in many collections. It has been bred by Straatman (pers. comm.) on Malaita, but no description of its preimaginal stages has been published.

There are four subspecies in the Solomons:—

G. mendana acous (Ribbe), 1898. Type loc.: Bougainville: Aco

G. mendana neyra (Rothschild), 1895. Type loc.: New Georgia

G. mendana mendana (Godman and Salvin), 1888. Type loc.: Guadalcanal: Aola

G. mendana aureofasciatum Racheli, 1979. Type loc.: NW Malaita: Dala

Distribution:— Bougainville: Aco; Isabel; Malaita: Dala; Rubiana; Rendova; Vella la Vella; Guadalcanal: Aola.

***Graphium agamemnon* (Linnaeus), 1758 (Figs 17-18)**

A widely distributed species having phenotypically similar populations practically throughout the Solomons. The only exception being found on Ugi and S. Cristobal inhabited by subspecies *ugiensis* (Jordan, 1909). This subspecies differs notably from the more widespread subspecies *salomonis* (Rothschild, 1895). Subspecies *ugiensis* was previously considered endemic to Ugi Is., however the ♀ holotype from Ugi matches well with many specimens from S. Cristobal I examined and I have no doubt that these specimens belong to the same subspecies.

I am also of the opinion that the presence or absence of red spots between the median veins of the HWs, as described by Jordan (1909), is an unreliable character for distinguishing between subspecies of *G. agamemnon*; whereas this character has been used to distinguish subspecies *ugiensis*, where the red spots are absent. An identical state also exists in specimens from other Solomons populations. In 100 specimens examined from localities throughout the species range, the red spots were found to vary in number, usually from three to seven. *G. agamemnon ugiensis* may be safely identified by the somewhat produced or falcate shape of the FWs, its smaller size and the more yellowish colour of the spots on the upper surface.

Distribution:— Bougainville; Shortland Is.; Alu; Choiseul; Isabel; Tatamba; Malaita; Kolombangara; Gizo; Rendova; Vella la Vella; Florida; Gela; Guadalcanal: Honiara, Koala Ridge; Ugi; S. Cristobal.

***Graphium meeki* (Rothschild), 1901**

This species is fairly rare and is confined inland, where it occurs in mountainous areas (Straatman, pers. comm.). It may be locally not uncommon in suitable habitats and I wonder if D'Abnera (1971) was misled by the apparent lack of recent specimens in his collections when he stated that the species is "probably extinct". The same author (1971) reports on another specimen to be found in the Australian Museum, Sydney. This specimen is presumably the same figured by Musgrave (1946) and seems not to have a different pattern from that of the holotype.

The species has been found in Bougainville (Rousseau-Decelle, 1946; Musgrave, 1946; D'Abnera, 1978); Isabel (type loc.) and Choiseul (Morgan, pers. comm.).

Distribution:— Bougainville: Porubi and Piva Riva, Empress Augusta Bay; Choiseul; Isabel: Hageulu 650 m.

***Graphium hicetaon* (Mathew), 1886**

Another species endemic to the Solomon Islands. It is widespread but has not previously been recorded from Isabel, Malaita and S. Cristobal. The geographic variation is



12



13



14



15



16



17



18

Figs 12-18. (12-13) *P. toboroi straatmani*: (12) ♂ upperside, S. Isabel, Holibara, 750m, 22.viii. 1964, Straatman leg., holotype in coll. Nieuwenhuis (Rijksmuseum van Natuurlijke Historie, Leiden); (13) ♂ underside, same specimen; (14) *G. mendana mendana*, ♂ upperside, Isabel, x.1972; (15) *G. mendana neyra*, ♀ upperside, Vella la Vella, 4.x.1973; (16) *G. mendana aureofasciatum*, ♂ upperside, NW Malaita, Dala, ex pupa, 1.vii.1964, Straatman leg; holotype in coll. Nieuwenhuis (Rijksmuseum van Natuurlijke Historie, Leiden); (17) *G. agamemnon salomonis*, ♂ upperside, Guadalcanal, v.1968; (18) *G. agamemnon ugiensis*, ♀ upperside, S. Cristobal, ix. 1974. Specimens in author's collection unless otherwise stated.

entirely insignificant, in spite of the isolation within the islands. Therefore, it might be assumed that there is a high degree of gene flow.

Distribution.— Bougainville: Kahili, Kunua, Kieta; Shortland Is.; Choiseul; Isabel; Malaita Rendova; Vella la Vella; Gizo; Florida; Guadalcanal, Ugi; S. Cristobal: Kira Kira.

Discussion

Distribution of Papilionidae in the Solomon Archipelago

Fifteen species of Papilionidae (or 16 if we consider *P. oberon* which inhabits Santa Cruz Island as belonging to this fauna) occur in the Solomons (Table 1) (*O. allottei* and *P. ponceleti* have been excluded because of their doubtful specific status—see text). Seven of these are endemic of which *O. victoriae*, *P. bridgei*, *P. woodfordi* and *G. hicetaon* are common and widespread in all the islands. Only *P. woodfordi* appears not to have reached San Cristobal. *P. toboroi* and *G. meeki* are apparently uncommon and confined to the eastern Solomons; *P. toboroi* is also to be found on Choiseul. *G. mendana* seems to have spread to most of the islands except San Cristobal, and to have developed in Malaita a subspecies with a striking colour pattern nearing that of *G. codrus*. Bougainville is the only island of the Solomons to have all the papilionid species known from the Solomons while San Cristobal has the lowest number (46.6%) (Table 1).

TABLE 1
Number of species of Papilionidae occurring on each
of the major islands of the Solomon Archipelago

Island	No. of spp	% of Archipelago total
Bougainville	15	100
Choiseul	13	86.6
Vella la Vella	9	60
New Georgia	13	86.6
Santa Isabel	14	93.3
Florida and Tulagi	11	73.3
Guadalcanal	12	80
Malaita	11	73.3
San Cristobal	7	46.6
Bellona	0	0
Rennel	0	0

It is interesting to note that there is a decrease in the number of papilionid species within the Solomon Archipelago between the islands from north to south and from east to west (Table 2).

Tables 3 and 4 show the ratios of papilionid species between the Solomons and the south-western Pacific/Australian region. It is worthwhile noting the high proportion of species endemic to the Solomons (Table 4), suggesting that these are relatively long established in these islands.

Comparison of distribution patterns

The Papilionidae of New Ireland and New Britain are identical both in number of genera and species of which 13% are endemic and 40% of Papuan origin. Seven species are shared with the Solomon Islands.

New Guinea, like the Solomons, has a high percentage of endemic species (40%), practically all confined to the genus *Ornithoptera*.

TABLE 2
Distribution of Papilionidae occurring in the Solomon Islands

Species	Bougainville†	Choiseul†	Santa Isabel†	New Georgia	Guadalcanal	Malaita†	San Cristobal	Santa Cruz
<i>O. victoriae</i>	*	*	*	*	*	*	*	
<i>O. allotiei</i>	*					*		
<i>O. urvillianus</i>	*	*	*	*	*	*		
<i>P. polydorus</i>	*	*	*	*	*	*	*	
<i>P. bridgei</i>	*	*	*	*	*	*	*	
<i>P. oberon</i>								*
<i>P. woodfordi</i>	*	*	*	*	*	*		
<i>P. fuscus</i>	*	*	*	*	*	*	*	
<i>P. phestus</i>	*	*	*	*				
<i>P. ulysses</i>	*	*	*	*	*			
<i>P. toboroi</i>	*		*			*		
<i>G. codrus</i>	*	*		*	*	*	*	
<i>G. sarpedon</i>	*	*	*	*	*			
<i>G. mendana</i>	*		*	*	*	*		
<i>G. agamemnon</i>	*	*	*	*	*	*	*	
<i>G. meeki</i>	*	*	*					
<i>G. hicetaon</i>	*	*	*	*	*	*	*	

† Islands on the eastern side of the Solomon Archipelago.

The fauna of the Admiralty Islands is not as rich as that of other nearby archipelagoes; 50% of the species are west New Guinean and only one is endemic, namely *Papilio weymeri* Oberthür which is related to *P. bridgei* of the Solomon Islands. Seven of the eight species known from the Admiralty Islands are shared with New Britain, New Ireland and the Solomons; five with Australia.

Australia has a rather small number of Papilionidae, three are endemic, namely *Protographium leosthenes* (Doubleday), *Graphium macleayanum* (Leach) and *Papilio anactus* Macleay, seven are Papuan or West Papuan and six Oriental.

On the Oceanic Islands, Santa Cruz, New Caledonia, New Hebrides, Fiji and Samoa, there are few Papilionidae; all but one are endemic at the species level, the exception being *P. canopus hypsicles* Hewitson, confined to the New Hebrides.

The close morphological and pattern relationships between the taxa inhabiting San Cristobal and NW Australia suggests a relationship between *hypsicles* and *fuscus*. Many authors are of the opinion that *P. canopus* from NW Australia is nothing other than a subspecies of *P. fuscus*. Whether *P. fuscus* and *P. canopus*, being allopatric, are two biological species is hard to say, nevertheless there is geographic evidence that *P. fuscus* spreads westward to the Oriental region as far as the Andaman Islands, and eastward to New Guinea, northern and eastern Australia and through the Solomons to the New Hebrides. *P. fuscus* is also reported from the Torres Islands, located between Santa Cruz and the New Hebrides, as ssp. *nomus* Gabriel 1936. The *canopus* complex, on the other hand, is restricted and split into various different populations in the Lesser Sunda Islands where it has developed tailed, tailless and colour forms probably of mimetic value.

TABLE 3. Summary of the distributions of Papilionidae in the Australian and south-western Pacific regions.

Species	Region														D
	NG	AI	NB	NI	SOL	SC	NH	F	S	NCL	AUS	LH	N		
<i>C. cressida</i>	*										*			P	
<i>P. polydorus</i>	*	*	*	*	*						*			P	
<i>T. oblongomaculatus</i>	*													P	
<i>O. goliath</i>	*													E	
<i>O. chimaera</i>	*													E	
<i>O. tithonus</i>	*													E	
<i>O. rothschildi</i>	*													E	
<i>O. paradisea</i>	*													E	
<i>O. meridionalis</i>	*													E	
<i>O. priamus</i>	*	*	*	*	*						*			P	
<i>O. alexandrae</i>	*													E	
<i>O. victoriae</i>					*									E	
<i>P. ulysses</i>	*	*	*	*	*						*			P	
<i>P. montrouzieri</i>										*				E	
<i>P. lorquinianus</i>	*													P	
<i>P. deiphobus</i>	*													P	
<i>P. ambrax</i>	*										*			P	
<i>P. phestus</i>		*	*	*	*									BS	
<i>P. albinus</i>	*													E	
<i>P. fuscus</i>	*		*	*	*		can				*, can			O	
<i>P. demoleus</i>	*										*			O	
<i>P. euchenor</i>	*		*	*										P	
<i>P. godeffroyi</i>									*					E	
<i>P. schmeltzi</i>								*						E	
<i>P. amyntor</i>										*			*	E	
<i>P. bridgei</i>					*									E	
<i>P. woodfordi</i>					*									E	
<i>P. oberon</i>						*								E	
<i>P. weymeri</i>		*												E	
<i>P. aegaeus</i>	*		*	*							*			P	
<i>P. laglaizei</i>	*													E	
<i>P. toboroi</i>					*									E	
<i>P. moerleri</i>			*	*										E	
<i>P. anactus</i>											*			E	
<i>G. thule</i>	*													E	
<i>G. aristeus</i>	*		*	*							*			O	
<i>G. wallacei</i>	*													E	
<i>G. browni</i>			*	*										E	
<i>G. hicetaon</i>					*									O	
<i>G. agamemnon</i>	*	*	*	*	*						*			P	
<i>G. meeki</i>					*									O	
<i>G. macfarlanei</i>	*	*	*	*							*			P	
<i>G. eurypylus</i>	*		*	*							*			O	
<i>G. gelon</i>										*				E	
<i>G. sarpedon</i>	*		*	*	*						*			O	
<i>G. mendana</i>					*									E	
<i>G. codrus</i>	*	*	*	*	*									CS	
<i>G. weiskei</i>	*													E	
<i>G. macleayanus</i>	*										*	*	*	E	
<i>P. leosthenes</i>											*			E	

Abbreviations: NG—New Guinea NH—New Hebrides LH—Lord Howe Is. CS—Celebes to Solomons
 AI—Admiralty Islands F—Fiji N—Norfolk Is. can—*Papilio canopus*
 NB—New Britain S—Samoa E—Endemic
 NI—New Ireland NCL—New Caledonia & Loyalties P—Papuan
 SOL—Solomon Islands Q—Oriental
 SC—Santa Cruz Islands AUS—Australia BS—Bismarck to Solomons

TABLE 4
Total numbers of species and percentages of Papilionidae occurring in the
Australian/south-western Pacific region showing faunal relationships

	New Guinea		Admiralty Islands		New Britain		New Ireland		Solomons		Australia		Entire Region	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Endemic	12	40	1	12.5	2	13.4	2	13.4	7	46.6	3	18.75	31	62
Papuan	11	36.7	4	50	6	40	6	40	3	20.1	7	43.75	11	22
Oriental	6	20	1	12.5	5	33.4	5	33.4	3	20.1	6	37.5	6	12
Bismarck to Solomons	0	0	1	12.5	1	6.6	1	6.6	1	6.6	0	0	1	2
Celebes to Solomons	1	3.3	1	12.5	1	6.6	1	6.6	1	6.6	0	0	1	2

Table 3 shows that only six species of Papilionidae are shared with Australia, New Guinea, the Bismarcks and the Solomons. They are *O. priamus* L., *P. polydorus* L., *P. ulysses* L., *P. ambrax/phestus*, *P. fuscus* Goeze and *G. agamemnon* L. The first four are typically Papuan, while the remaining two are Oriental and are faunal elements derived presumably from west of the Wallace line.

As suggested by Zeuner (1943), *O. priamus* has had successive waves of dispersal from the central Moluccas eastwards. Holloway (1973) is not in agreement with Zeuner regarding the origin and dispersal of the genus *Troides*. In any case, if *Troides* had a centre of dispersal in mainland Asia, this is not in contrast with the distribution of *Ornithoptera priamus*, *Pachliopta polydorus*, *Papilio ulysses* and *Papilio ambrax/phestus*. While it is difficult to demonstrate the exact centre of origin of *Ornithoptera*, which probably originated within Wallacea according to Zeuner (l.c.), *Pachliopta* and *Papilio* certainly spread from India and Asia to the Papuan region. It might be hypothesized that *P. ulysses* originated from a common ancestor of the *peranthus/ulysses* group which gave origin to *P. lorquinianus* C. & R. Felder and *P. ulysses* within Wallacea. The former remained restricted to the Moluccas and West Irian, while the latter spread eastwards. The *ambrax/phestus* complex is structurally similar to *P. polytes* L., and has probably recently separated into species. *P. polytes* is polymorphic in its females and linked to Batesian mimicry, while *P. ambrax* and *phestus* females are monomorphic, nevertheless dissimilar from males and related to a Batesian-Mullerian mimicry ring. It has been demonstrated that *P. ambrax* Boisd. and *P. aegeus* Don. are both synchronic and sympatric in some parts of their range, while there is no evidence that the ecology of the supposed models, i.e. *Cressida cressida* F. males and *P. polydorus* is the same. In the light of recent investigations on *P. memnon* L. carried out in Sumatra (Küppers, 1977) it is probable that Batesian mimicry, at least in Papilionidae, is not as common as might be expected.

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References

- Blandin, P., 1973. Etudes sur le genre *Ornithoptera*: remarque préliminaires sur les relations phylogénétiques entre *O. alexandrae*, *O. victoriae* et *O. priamus* (Papilionidae). *Alexanor* 8: 63-64.
- D'Abbrera, B., 1971. *Butterflies of the Australian region*. Lansdowne, Melbourne.
- D'Abbrera, B., 1975. *Birdwing butterflies of the world*. Lansdowne, Melbourne.
- D'Abbrera, B., 1978. *Butterflies of the Australian region*. 2nd edn. Lansdowne, Melbourne.
- Gressitt, J. L., 1961. Problems in the zoogeography of Pacific and Antarctic species. *Pacif. Insects Monogr.* 2: 1-94.
- Haugum, J. and Low, A. M., 1978. *A monograph of the birdwing butterflies*. Introduction. *Ornithoptera* (Atheoptera). Vol. 1, p. 1. Scandinavian Sci. Press, Klampenborg.
- Holloway, J. D., 1971. The affinities within four butterfly groups (Lepidoptera: Rhopalocera) in relation to general patterns of butterfly distribution in the Indo-Australian area. *Trans. R. ent. Soc. Lond.* 125: 125-176.
- Howarth, T. G., 1977. A list of the type-specimens of *Ornithoptera* (Lepidoptera: Papilionidae) in the British Museum (Natural History). *Bull. Br. Mus. nat. Hist. (Ent.)* 36: 153-169.
- Howarth, T. G. and Racheli, T., 1975. Some observations on *Pachliopta polydorus* (Linnaeus) (Lepidoptera: Papilionidae) from the Solomon Islands. *Trans. Lep. Soc. Jap.* 26: 8-13.
- Jordan, K., 1909. Papilionidae. In Seitz, A. (Ed.), *Die Gross-Schmetterlinge der Erde* 9. A. Kernen, Stuttgart.
- Küppers, P. V., 1977. Zur Problematik der Bates' schen mimikry bei *Papilio memnon* L. und seinen "Vorbildern". In: Roesler, R. U. und Küppers, P. V., *Beiträge zur Kenntnis der Insektenfauna Sumatras*. Teil 6. Betrachtungen zum Problemkreis "mimikry" am Beispiel südostasiatischer Insekten. *Beitr. naturk. Forsch. Südwestf.* 36: 134-151.
- Le Moul, E., 1933. Formes nouvelles ou peu connues de Papilionidae. *Nov. ent.* 3: 15-16.
- McAlpine, D. K., 1970. A note on the status of *Ornithoptera allottei* (Rothschild) (Lepidoptera: Papilionidae). *J. Aust. ent. Soc.* 9: 233-234.
- Munroe, E., 1961. The classification of Papilionidae. *Can. Ent. Suppl.* 17: 1-51.
- Musgrave, A., 1946. Some butterflies of Australia and the Pacific. The Swallowtails. *V. Aust. Mus. Mag.* 9: 104-108.
- Racheli, T., 1979. New subspecies of *Papilio* and *Graphium* from the Solomon Islands. *Zool. Meded., Leiden* 54: 237-240.
- Ribbe, C., 1898. Beiträge zur Lepidopteren-Fauna des Bismarck und Salomon-Archipels in der Südsee. *Dt. ent. Z. Iris* 11: 36-133.
- Ribbe, C., 1907. Zwei neue Papilioformen von der Salomo-Insel Bougainville. *Dt. ent. Z. Iris* 20: 59-63.
- Rothschild, W., 1895. A revision of the Papilios of the eastern hemisphere, exclusive of Africa. *Novit. Zool.* 2: 167-463.
- Rothschild, W., 1914. Description of a new *Troides*. *Novit. Zool.* 21: 275.
- Rousseau-Decelle, G., 1939. Notes sur un nouvel exemplaire de *Troides allottei* Rothschild (Hybride d'*Ornithoptera victoriae regis* Rothschild et d'*Ornithoptera urvilleanus* Guérin). *Bull. Soc. ent. Fr.* 44: 97-101.
- Rousseau-Decelle, G., 1946. Contribution à l'étude des *Papilio* de la faune Indo-Océanienne (Lep. Papilionidae). *Bull. Soc. ent. Fr.* 51: 128-133.

- Sands, D. P. A. and Sawyer, P. F., 1977. An example of natural hybridization between *Troides oblongomaculatus papuensis* Wallace and *Ornithoptera priamus poeidon* Doubleday (Lepidoptera: Papilionidae). *J. Aust. ent. Soc.* 16: 81-82.
- Schmid, F., 1970a. Consideration sur la mâle d'*Ornithoptera allottei* Rothschild et sur la phylogénie des Ornithoptères. *J. Lepid. Soc.* 24: 88-105.
- Schmid, F., 1970b. Sur quelques sous-espèces d'*Ornithoptera victoriae* Gray (Papilionidae). *Naturaliste Can.* 97: 467-475.
- Schmid, F., 1973a. Sur quelques sous-espèces d'*Ornithoptera victoriae* (Lepidoptera: Papilionidae) II. *Can. Ent.* 105: 701-108.
- Schmid, F., 1973b. A propos d'Hybridism naturel chez les Ornithoptères (Lepidoptera: Papilionidae). *Tijdschr. Ent.* 116: 161-169.
- Straatman, R., 1962. A hybrid between *Papilio aegaeus aegaeus* and *Papilio fuscus capaneus*, with a note on the larval foodplants. *J. Lepid. Soc.* 16: 161-173.
- Straatman, R., 1969. Notes on the biology and host plant associations of *Ornithoptera priamus urvilleanus* and *O. victoriae* (Papilionidae). *J. Lepid. Soc.* 23: 69-76.
- Straatman, R., 1975. Notes on the biology of *Papilio laglaizei* and *P. toboroi* (Papilionidae). *J. Lepid. Soc.* 29: 180-187.
- Straatman, R., 1976. Hybridisation of birdwing butterflies (Lepidoptera: Papilionidae) in Papua New Guinea. *Trans. Lepid. Soc. Jap.* 27: 156-162.
- Yoshida, M., 1972. *Graphium codrus solon* is a good subspecies. *Trans. Lepid. Soc. Jap.* 23: 48-50.
- Zeuner, F. E., 1943. Studies in the systematics of *Troides* and its allies. *Trans. zool. Soc. Lond.* 25: 107-184.

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BARKER, S.

1980. New species and new synonyms of *Stigmodera (Castiarina)* (Coleoptera: Buprestidae). *Trans. R. Soc. S. Aust.* 104(1): 1-7, text-figs 1-3.

CAMPBELL, M. H.

1978. New hope for a remedy. *Agric. Gaz. N.S.W.* 89(3): 47.
Formicidae: *Pheidole* spp.

CROSBY, D. F.

1979. No title. In Exhibits. *Victorian Ent.* 9(3): 21.
Lepidoptera: several butterfly species
1980. A new locality for *Hesperilla crypsargyra lesouefi* (Lepidoptera: HesperIIDae). *Victorian Ent.* 10(1): 2-3.

De BAAR, M.

1979. Some butterflies and other insects on *Buckinghamia celsissima* F. Muell. in Brisbane. *News Bull. ent. Soc. Qd* 7(3): 36-38.
Lepidoptera: Lycaenidae (5 spp) and Limacodidae (undet. larva)
Hymenoptera: 4 species
Coleoptera: *Leis conformis*

GAEDIKE, Reinhard

1979. Katalog der Epermeniidae der Welt (Lepidoptera). *Beitr. Ent., Berlin* 29(1): 271-288.

GOODYER, G. J.

1979. Black-headed pasture cockchafer. *Agric. Gaz. N.S.W.* 90(4): 31-32, illustr.

GREBER, R. S. and GOWANLOCK, D. H.

1979. Cereal chlorotic mottle virus—purification, serology and electron microscopy in plant and insect tissues. *Aust. J. Biol. Sci.* 32(3): 399-408, text-figs 1-6.
Hemiptera: *Nesoclutha pallida*